It is sometimes necessary to determine the densities of plants in experimental plots which have been sown to some crop or other. Where the seed has been sown in rows, it is a simple matter to count the number of plants growing in unit lengths of row, and then compute the total number of plants per plot. Where the seed, however, has been broadcast the method in which the density of plants, or the total number of plants per plot, is determined, is different.

When seed is broadcast over a plot, the manner in which the seed falls to the ground is a random process, and the dispersion of the seed over the plot may be described by the Poisson distribution (Feller, 1957). The Poisson distribution is given by

$$P(k \text{ plants growing on unit area a}) = \frac{da^k e^{-da}}{k!}$$

where d is the density of plants per unit area. The probability of zero plants growing in any unit area is then e^{-da}. Now, if n quadrats are placed at random in a plot, and it is found that y quadrats contain no plants then

$$y = ne^{-da}$$

$$\text{and } d = \frac{\log n - \log y}{a \log e} \qquad \ldots\ldots\ldots\ldots\ldots(1)$$

which means than the density of plants may be computed from a knowledge of the total number of quadrats which are used for sampling and the number of quadrats containing no plants. By using this relationship the necessity for counting the number of individuals in the quadrats is eliminated.

When using the relationship (1) care must be taken to choose a quadrat size which will not be, (a) so large that it always contains plants, or, (b) so small that the number of empty quadrats is too large. It is recommended that a rough estimate of the average density of the individuals first be made over all treatments in the experiment. The size of quadrat which will give the desired percentage of empty quadrats may then be computed from

$$a' = \frac{\log 100 - \log y'}{d' \log e}$$

where a' is the area of the quadrat, y' the desired percentage of empty quadrats and d the estimate of average density. It is recommended that y' equal 50 to 60 percent. With y' equal to 50 percent, 34 percent of the quadrats will contain one plant, 12 percent two plants, and four percent more than two plants.

In order to determine the number of quadrats which are required to detect predetermined significant differences in densities the following relationship is used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{v}} \sqrt{n} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Since the variance (v) of the Poisson distribution is equal to the mean (da), equation (2) may be rewritten in the form

$$n = \frac{2t^2 da'}{(d_0 a)^2}$$

where d_0 is the difference in density you wish to regard as being significant, and $t = 1{,}96$ for $P = 0{,}05$, or 2,58 for $P = 0{,}01$.

The estimates of density should be transformed, using a square root transformation, before being subjected to an analysis of variance.

REFERENCE

FELLER, W., 1957. *An introduction to probability theory and its applications*. New York: Wiley.

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